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Cardiac rehabilitation testing of a high-intensity performance athlete firefighter after myocardial infarction, placement of stents and an implantable cardioverter-defibrillator

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ABSTRACT

Firefighters have one of the most stressful, physically demanding jobs to perform across the emergency services field and often suffer from job-related health conditions. A firefighter from California contacted our Baylor Heart and Vascular Hospital cardiac rehabilitation program with the hope of returning to work after myocardial infarction, placement of stents, and implantable cardioverter-defibrillator implantation. He underwent high-intensity performance testing (HIPT) developed for firefighters seeking to return to duty after cardiac events. The information gathered from the HIPT allowed the firefighter to be medically managed, return to duty, and remain active in rock climbing and his firefighting profession for the past 2 years.

KEYWORDS Athlete; cardiac rehabilitation; firefighter; implantable cardioverter-defibrillator; myocardial infarction

The US Department of Labor job description for a firefighter[1] incorporates multiple tasks defined as "very heavy work," such as lifting, carrying, pushing, pulling, and climbing. The National Fire Protection Agency requires firefighters to perform a graded exercise stress test and reach a 12 metabolic equivalent (MET) minimum standard,[2] and lists "functioning as an integral component of a team, where sudden incapacitation of a member can result in mission failure or in risk of injury or death to civilians or other team members" among the essential job tasks.[2] This requirement leads to firefighters being asked to retire after implantable cardioverter-defibrillator (ICD) placement.

CASE DESCRIPTION

A 31-year-old firefighter with no family history of cardiac disease or hypercholesterolemia experienced a myocardial infarction while rock climbing and underwent stent placement in his left anterior descending artery with subsequent ischemic cardiomyopathy. He then enrolled in a 36-session, conventional cardiac rehabilitation program during which his stent claudicated, resulting in cardiac arrest. After repeat angioplasty, re-expansion of the stent, thrombus extraction, and placement of a VVI-paced ICD, he completed the remaining sessions without incident. Arrhythmia detection of ventricular tachycardia/fibrillation was set at 171 to 240 beats/min, with a lower rate of 40 beats/min and upper rate of 110 beats/min.

The patient aimed to return to rock climbing (8-11 METs) and work as a firefighter (12-14 METS),[3] both unreachable in conventional programs due to a universally assumed graduation goal of 6 to 8 METs.[4] The patient thus sought out the Walter I. Berman Cardiovascular Prevention and Rehabilitation Center's high-intensity testing laboratory[5–9] at Baylor Scott & White Heart and Vascular Hospital. We developed a six-session high-intensity performance testing (HIPT) regimen that was occupation-specific[10,11] and symptom limited,[12] meaning that no heart rate or blood pressure limit was used to restrict exercise intensity *(Figure 1)*. During the first and final session, a maximal metabolic stress test was completed wearing full firefighter turnout gear and a calibrated metabolic system (QUARK,

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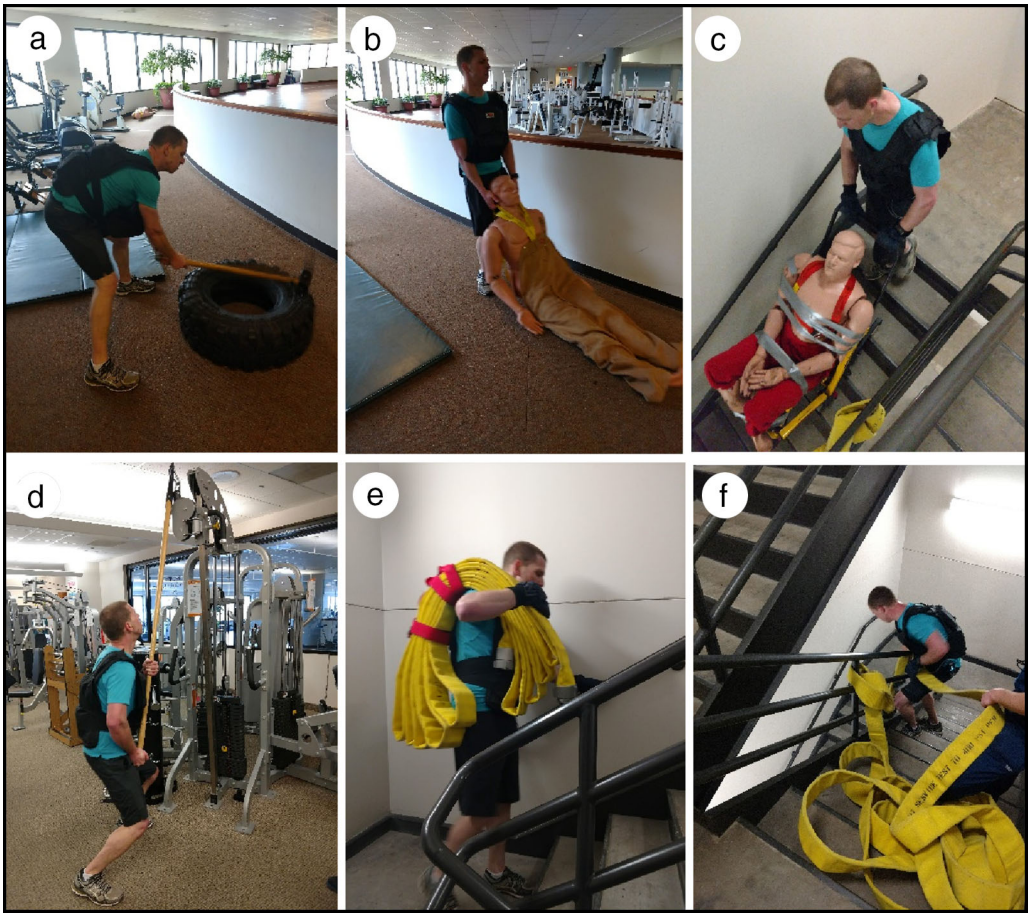

Figure 1. Firefighter high-intensity performance testing: **(a)** forcible entry simulated with sledgehammer; **(b, c)** rescue with weighted dummy; **(d)** ceiling breach and pull with pike pole and weighted resistance machine; **(e)** equipment carry with fire hose up multiple-floor building; **(f)** stair climb and hose pull.

Cosmed USA, Chicago, IL), which collected and recorded his oxygen consumption. The protocol included 3-minute stages at speeds of 1.7 to 4.2 mph and changes in grade from 10% to 16% until termination criteria were met.[13]

The patient's ICD implant site, hemodynamics, and continuous three-lead electrocardiogram were evaluated throughout each session. In-person device interrogation was performed by the ICD manufacturer representative at the first and last sessions. Thereafter, the ICD was interrogated and monitored remotely by the manufacturer. While the patient wore a weighted vest, both cardiovascular intensity and weight loads were gradually increased, starting at 15 pounds, with increments of 10 pounds added every session until the weight mirrored his turnout gear *(Table 1)*. During HIPT, the patient's hemodynamics remained within acceptable ranges (means, 152/70–160/70 mm Hg and 172–181 beats/min), and the mean peak rate-pressure product (27,552 ± 1408) was within the 36,000 threshold.[12] A functional capacity of 12.1 METs was achieved on the final metabolic stress test, with occasional premature ventricular contractions and asymptomatic episodes of nonsustained ventricular tachycardia, with a rate of 142 to 181 beats/min in 3- to 6-second duration over a period of 2 minutes 6 seconds observed.

DISCUSSION

With our HIPT approach, the patient reached extreme levels of physical exertion in a controlled, monitored setting and demonstrated his ability to perform the simulated firefighting tasks without any adverse symptoms, arrhythmias, or ICD shocks. The HIPT data were provided to the patient's supervising physician and precinct fire chief, and the patient was medically managed and allowed to return to his profession and sports. Two years out, he remains active in rock climbing and as a firefighter and has had no negative cardiovascular symptoms or events. Without the HIPT approach, the patient, physician, and fire chief would not have been aware of his capacity to perform his profession and sports. Decisions regarding return to high-intensity professions in particular require demonstration that the individual can safely perform at the required intensities, since in professions such as firefighting, law enforcement, and oil rig operations, additional lives are at risk.[5–9] Evidence-based decisions about return to work (and/or sport) are needed, as blanket prohibitions against participation in high-intensity professions and sports for all patients with ICDs are inappropriate and could be unnecessarily detrimental to the identity, livelihood, emotional stability, and recovery of the patients and their families.[14–16] Rather, as in this case, the physician,

Table 1. Firefighter tasks and equipment loads

Firefighter task	Equipment carried	Weight of gear (lb)	Weight of equipment (lbs)	Total weight carried (lbs)
Stair climb and hose pull	Fire hose	15–55	15–30	30–85
Hose drag	Fire hose	15–55	30–60	45–115
Equipment carry	Weighted box	15–55	11.5–50	26.5–105
Forcible entry	Sledgehammer	15–55	15	30–70
Search	Fire hose/weighted dummy	15–55	50–165	65–220
Rescue (multiple environments)	Weighted dummy	15–55	60–165	75–220
Ceiling breach and pull	Pike pole	15–55	20	35–75

job-related supervisor, and patient should make an informed decision based upon the condition of the patient, considering all variables[16]—including emotional and environment stressors that cannot be simulated in the laboratory.

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